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MEASURES TO STRENGTHEN INDIGENOUS TECHNOLOGICAL CAPABILITIES IN THE PRODUCTION OF BUILDING MATERIALS *

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I. SUMMARY

1. The issue paper examines the need of developing countries to strengthen their indigenous technological capabilities and the measures which should be taken at the national, regional and international level in this respect.

2. The paper examines the efforts required to widen the scope of building materials based on locally available resources. While the majority of these efforts are needed in the fields of research, standardization and quality control, special attention has to be paid to the dissemination of research results among consumers and industry. It also asserts that existing building codes and regulations very often hamper the use of indigenous building materials and have to be updated and adapted to local conditions.

3. Most enterprises in developing countries, when confronted with the selection of equipment, are handicapped by the lack of proper information and advice. Therefore, it is suggested that industrial information systems and consultancy services at the local level should be strengthened as well as the negotiation capabilities of decision-makers.

4. The paper also asserts that training of skilled workers as well as improvement of managerial capabilities is needed. It points to the desirability of mastering the design and production of capital goods for the manufacture of building materials. It is, therefore, suggested that developing countries, according to the degree of their development, establish the necessary conditions for the production of single tools, capital goods of low technological complexity and spare parts.

5. The Consultation is requested, inter alia, to deliberate on the:

- Ways and means of strengthening indigenous technological capabilities for the production of building materials in developing countries;
- The role of international co-operation towards this end.

6. The detailed points proposed for discussion by the Consultation are included in para.35 of this paper.

II. INTRODUCTION

7. Many developing countries do not have clear policies regarding the ways and means to increase the production of building materials in order to cope with the increasing demands in the years to come. A strategy to develop the local production of building materials has to be based on an assessment of the needs and available resources and on the need to master the technology for producing suitable materials. This involves a number of related problems. In the first place, based on an assessment of existing resources, countries will have to choose products for which they have adequate raw materials. This implies the establishment of raw materials inventories and undertaking research for the development of products based on those resources. Once the choice of products has been made and local production is envisaged, the developing countries will have to solve the problems related to the choice of technology, its adaptation to local needs and the training required at all levels to use the technology. An important step in the development of a self-sustaining building materials industry is the mastery of design and production of required capital goods. This issue paper discusses each of these aspects and the measures to strengthen indigenous technological capabilities in the production of building materials.

III. CHOICE, RESEARCH AND DEVELOPMENT OF PRODUCTS

8. Most developing countries have established their patterns of consumption of building materials on the basis of construction techniques - and as a consequence the building materials - used in developed countries. This has led to a considerable import dependency of the construction industry and to a prejudice and neglect of the locally-produced materials. In a situation of reduced foreign exchange availability, most of these countries cannot continue to devote an important part of their foreign exchange earnings to the importation of building materials and have therefore to find ways to promote import substitution in this sector.

9. The wealth of natural resources suitable for conversion into building materials has not been adequately utilized in many regions. There is a general dearth of adequate information on the raw materials required for the production of building materials. In most cases, information on the location of raw materials is available, but an evaluation of the extent and quality of reserves is lacking. In the absence of such an evaluation it becomes

difficult to determine the suitability of the raw materials to support production ventures.

10. The choice of products and the scope for substitution varies from one type of construction to another. For example, the range of materials suitable for use in civil engineering projects is normally quite limited: cement, steel, bitumen and a variety of aggregates and filling materials are the main materials consumed by the sub-sector. However, considerable progress has been made in the last few years in the promotion of other materials, such as wood, for structural purposes.

11. In contrast to civil engineering structures, in housing and residential buildings there is a wide range of possible choices of building materials. For example, it is generally accepted that in some construction applications, the superior strength qualities of portland cement are not essential and that substitute binders like lime and lime-pozzolana could be used to achieve the desired results. Even though most countries have raw materials for the production of lime (in the form of limestone, dolomite or sea-shells) and there is a wide range of technologies available for its production, not much has been done to increase the supply and promote its use in building.

12. Large deposits of natural pozzolana can be found in countries which have experienced volcanic activities in the past. Artificial pozzolana can be produced from clays, bauxite waste and the burning of rice-husk. In some countries of Asia, commercial plants are in operation for the production of cementitious binder from rice-husk ash and lime. It has also been found that ashes from the burning of rice straw, dried banana leaves and bagasse show good pozzolanic properties. To increase the use of these materials, adequate promotion activity backed by research and development work is required.

13. Wood has for a long time been neglected as a building material in developing countries, in spite of the fact that many of these countries have important underutilized forest resources. Many factors have contributed to this: building codes and regulations; prejudices against the behaviour of wood under fire or biological factors; insufficiency of the productive sector; etc. Experience in developed countries has shown that wood is a good building material and great improvements have been made to increase its durability and fire resistance. Timber and wood panel materials have a great

potential for use in construction, for structural purposes in simple housing frames one or two storeys, bridges, etc. as partition and fill material, and for exterior and roof covering. The First Consultation on the Wood and Wood Products Industry discussed the promotion of the use of wood in construction in developing countries. It recommended that research on the properties of wood, especially of the less accepted species, should be increased, that information on existing and new uses of wood in construction should be disseminated in developing countries, and that training related to the use of wood in construction be promoted. 1/ *

14. Soil is the most extensively used building material in rural areas in the developing world. In India, for example, according to the 1971 Census there was a total housing stock of 93.0 million dwelling units in the rural areas out of which 72.2 per cent employed mud as their principal building material, particularly for walling in one way or another. Extensive studies undertaken in research laboratories all over the world, have led to recommendations on construction techniques that would help to prolong the service life of earth buildings. These include incorporation of stone or other masonry foundations, use of agricultural fibres to reduce shrinkage, use of extended overhangs at the eaves and use of low-cost protective coatings. Research made on stabilization of soil has shown that its strength properties can be improved by using cement, lime, bitumen, and other chemical compounds. It must be recognized, however, that most of these innovations have not found widespread application. Successful promotion of those will depend on the capability of governments to limit public prejudice against unbaked soil materials, the improvement of the technical know-how of potential users, and the increase in the availability of some products (e.g. stabilized soil blocks) by mass-production for sale to the public.

15. In many developing countries the absence of standards and quality control of locally produced building materials has negatively affected their use in construction. Efforts to develop national and regional standards are needed, since their establishment and acceptance would greatly promote the use of indigenous building materials and also increase international trade. Also, outdated building codes and regulations in many developing countries constitute a barrier to the use of indigenous building materials. The

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* Notes are provided at the end of this paper.

reformulation of codes and their adaptation to local conditions would make them a valuable instrument for a more rational use of available raw materials in construction. 2/

16. A number of actions are necessary to broaden the choice of building materials and to make better use of available resources. Information on existing deposits of underutilized raw materials has to be collected and processed. Considerable research efforts are required to develop "new" building materials, to encourage the use of agricultural waste materials and to improve standardization and quality control. The transfer of these research results and developments to the manufacturers seems to cause some difficulty despite the construction of pilot plants and demonstration units in several locations. Mechanisms to establish improved co-ordination between research institutions and end users will have to be developed to ensure that researchers are aware of the problems of industry and also to guarantee that the results of research are disseminated to the productive sector. 3/

IV. SELECTION AND ACQUISITION OF TECHNOLOGY

17. Most surveys conducted on this sector in developing countries show a situation of underutilized capacities caused by the inadequacy of the existing equipment, the lack of trained manpower and deficiences in the organization of production. In the case of the cement industry many countries which have opted for large highly automated plants are facing very low capacity utilisation. In brickworks it was found that mechanized units tended to operate close to the production capacities, whereas automated brickworks faced serious constraints.

18. In the ESCAP region underutilization is usually caused by interruptions in supply of raw materials and other inputs, equipment breakdowns, and difficulties in obtaining spare parts, lack of skills and motivation among workers due to high turnover and poor organization, and shortcomings in planning and management. Another cause for underutilization has its origin in the choice of technology adopted, which may impose a scale of production in excess of that which the local market can support. 4/

19. Recent surveys, sponsored by ECA, of cement plants in Benin, Ghana, Ivory Coast, Liberia, Nigeria, Senegal, Togo and Burkina Faso showed that for

integrated cement plants the rate of capacity utilization in 1982 ranged between from 15 to 90 per cent with an average of 65 per cent. The capacity utilization in clinker grinding plants for the same year ranged from 33 to 87 per cent with an average of 57 per cent. The factors underlying the apparent poor performance of building materials plants in African countries are many and varied, and include the following:

- Poor project conception including use of inappropriate technologies, overestimation of demand at the planning stage, lack of foreign exchange to purchase needed spare parts and (sometimes) importation of raw materials to keep plants running.

- High energy costs.

- Poor management practices and lack of the requisite skilled manpower. The effect of this has been conspicuous particularly in cases where turn-key projects based on capital intensive technologies were handed over to the local owners. There have been cases where management contracts have been awarded to consulting organizations to help improve the efficiency and profitability of building materials plants in some African countries. 5/

20. Profound changes have occurred in the last years in the capital goods industry in developed countries. In most branches automation and robotization have revolutionized the production systems. The building materials industry has also been influenced by it. Fully automated plants have reduced the need for manual workers since their functions have increasingly been taken over by highly sophisticated machines and by technicians and engineers.

21. Countries wanting to enter or to expand the building materials industry are facing a situation where different technologies exist and have been tried in the developing world. Most building materials can be produced either in a semi-industrial manner or in mechanized or automated plants. What criteria should developing countries apply in the selection of technology and/or production capacity? So far, only a few developing countries have adopted explicit technological plans and strategies.

22. Currently, it is not possible to assert the absolute superiority of one technology over another. One technology can only be considered superior to another when the socio-economic conditions prevailing in the country in which it is to be applied at a given time are taken into account. This evaluation depends on a large number of factors such as the level of industrialization of the country, urban or rural demand, the available infrastructure (ports, roads, railways, etc.), the cost of distribution and the availability of

skilled manpower. Most enterprises, when confronted with the selection of equipment are limited in their choice by the lack of information and of indigenous consultancy services.

23. The need to strengthen the evaluating capacity for a better choice of technology can be exemplified by the case of the brick-making industry. In brickworks it is possible to combine equipment items of different technical levels. Entirely manual extraction and preparation processes can be combined with forming and firing processes using improved or mechanized presses, auger machines and non-continuous kilns. Techniques with a high labour content or improved or mechanized techniques for preparing, forming and drying the clay are in some cases more efficient than highly mechanized and automatic techniques. 6/ Adequate assistance would help entrepreneurs to avoid acquisition of unnecessary capital-intensive components.

24. Selection among available options is also very often hampered by the equity composition of joint-ventures and foreign enterprises. The source from which credit facilities may be available often determines the choice of a specific country. Another factor worth investigating relates to the conditions on technology options tied to loans by international lending agencies.

25. More often than not adequate information for the importing firm on alternative types of equipment is lacking. Moreover, the information is often one-sided. Most of it is focused on large-scale technologies, while information on small- and medium-scale technologies is virtually non-existent. The strengthening of information systems on alternative technologies for products like cement, bricks, lime, sand and cement breeze-blocks, emphasizing the small- and medium-scale units would permit many developing countries to make a better choice. Also, assistance to improve the evaluating capacity of different types of machinery would increase the ability of making adequate choices. Strengthening of industrial and information centres and the promotion of consultancy capabilities should be viewed as key factors in a better selection of technology for the country.

26. The conditions under which technology is acquired constitutes a continuous concern to developing countries. Decision-makers from government and the private sector are very often unaware of the possibilities to negotiate more

advantageous contracts for the acquisition of technology. To strengthen their negotiating capabilities different actions could be undertaken, like training courses, preparation of manuals, checklists for contractual arrangements, etc.

V. TRAINING

27. The type of training required has to be seen in connection with the level of complexity of the productive technology which is to be employed. For instance, in the case of cement production the automation of dry-process rotary kilns has forced a change in the structure of skills required as compared with those of older technologies: engineers and technicians represent nearly 40 per cent of the staff.

28. The training of skilled workers for new tasks and the training of technicians is receiving increasing attention from decision-makers in certain developing countries and in foreign companies that have carried out technology transfer operations.

29. In order to improve the performance of plants, a number of major firms from developed countries have concluded technical assistance contracts with developing countries, limited most of the time to improve individual know-how. However, the mere acquisition of individual know-how, although necessary, is not sufficient. In complex plants, know-how cannot be confined to single operations - no type of know-how can be expressed independently of other types. In fact, despite differences in content, manual workers, technicians and engineers have know-how that is interrelated - and mutually complementary in the manufacture of the finished product. Companies in industrialized countries must certainly transmit knowledge regarding the operation of machines, but also and above all their experience regarding the operation of plants as a whole. 7/

30. There is certainly great scope to increase co-operation between developed and developing countries in training in this sector. Developed countries, among other things, facilitate the access of students from developing countries to training institutions in developed countries and assist in the establishment and finance of training programmes, both in developed and developing countries. At the enterprise level, the development and improvement of long-term training arrangements in connection with transfer of technology seems to merit attention.

31. Some developing countries have already achieved considerable experience and expertise in training human resources in the building materials industry. This is the case in some Asian and Latin American countries and in the Maghreb countries. This experience could be usefully shared with other developing countries from the same region or subregion by means of the establishment of training institutions of regional character, which could provide technical and on-the-job training. Information about the training needs and training opportunities could be disseminated by the establishment of international information networks in order to increase communication among existing institutions and to promote co-operation.

VI. PRODUCTION AND ADAPTATION OF EQUIPMENT

32. In order to have a viable self-sustaining industry, it is necessary for the developing countries to gain a complete mastery of the production processes of building materials. It would be that much to their advantage if, in addition, they are able to master the knowledge of design and production of capital goods that manufacture the building materials. The creation of a national engineering capability which can meet these requirements has a number of advantages:

- It would permit the adaptation of equipment to local conditions;
- It would ensure expertise in the functioning of capital goods;
- It would provide for the manufacture of spare parts, thus reducing import dependence;
- It would make use of technological potential adapted to the levels of training of the work-force and management.

33. Engineering capability can also contribute to greater national self-sufficiency by tailoring technological choices to the adaptation and assimilation of capital goods. The training of engineers and senior technicians, and the establishment of research and development institutes, seem to be prerequisites for the acquisition of engineering capability at the national level.

34. Developing countries not capable of producing highly complex capital goods (e.g. cement works with long rotary kilns using the wet or dry process), could nevertheless establish the necessary conditions for the production of

single tools, capital goods of low technological complexity (mini-cement works for example) and spare parts. Expertise in the production of this type of plant would make it possible to progress gradually towards a mastery of production of increasingly complex equipment. Finally, a policy favouring the production of capital goods in the national territory would enable the developing countries to make a real "technological leap".

Points for discussion

35. The Consultation is invited to consider the following:

(i) What kind of measures could be adopted at the national, regional and international level in order to improve developing countries' research and development capability for building materials for which they have adequate raw materials? What is the scope for international co-operation to improve standards and quality control in developing countries? What measures could be undertaken to reformulate existing construction codes and regulations in developing countries in order to increase the use of indigenous building materials?

(ii) How can indigenous consultancy capabilities be promoted in developing countries, and industrial and information centres be strengthened to allow a better selection of technology? What is the scope of improving the negotiating capability of developing countries in the acquisition of technology, and what kind of measures could be undertaken to that end?

(iii) What is the scope for increased co-operation between developed and developing countries and among developing countries themselves in the field of training for building materials industries? What should be the role of international co-operation, both at the enterprise, government and the international organizations' level?

(iv) Could developing countries envisage the production of tools, spare parts and simple equipment? If so, what are the ways and means of international co-operation towards this end?

Notes

1/ UNIDO, Report of the First Consultation on the Wood and Wood Products Industry, ID/306, p.7. See also, Marcelo Tejada, Promoting the use of wood in construction, UNIDO, ID/WG.395/2, 1983.

2/ Gyula Sebestyén, Research priorities for the building materials industry in developing countries, UNIDO, ID/WG.425/1, 1984.

3/ ESCAP/UNIDO, The building materials industry in the ESCAP region, Division of Industry, Human Settlements and Technology of the Economic and Social Commission for Asia and the Pacific, Bangkok (mimeo), 1984, p.15.

4/ ibid., p.12.

5/ ECA, Needs, constraints and prospects of African countries regarding the availability of building materials (mimeo), 1983, p.5.

6/ Sid Boubekeur, Outline of a policy for mastering capital goods technology, UNIDO, ID/WG.425/4, 1984, p.50.

7/ ibid., p.35.